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GEOLOGY AND PALÆONTOLOGY.

THE TERTIARY ERUPTIVE ROCKS.—The trachytic formation is a most interesting one, but also very complicated. Hungary may be considered as the cradle of our notions respecting it since the time of Beudant. Richthofen imported the classification to California as it was established about eighteen years ago, based chiefly on habitus-characters. The geologists of the Vienna school have continued the study of it, and about some twelve years ago they published the geological map of Hungary too, also showing the considerable progress made since the departure of Richthofen.

The geologists of the 40th parallel have accepted as a base the classification of Richthofen, but with some alterations suggested by Zirkel; and that is about the classification adopted by Endlich and the other geologists of Prof. Hayden's staff, with the only difference that they have abandoned the propylite.

Owing to the method employed, the petrographical part, as regards the feldspars, the true base of classification is incomplete: firstly, the plagioklastic feldspars are not distinguished specially; secondly, every glassy feldspar has been taken for (potash) sanidine, which is not the case.

In Hungary and some adjacent countries, the trachytes have been the object of my detailed studies nearly since Richthofen's time. I commenced as field-geologist, and have continued as such, but making the aid of petrography serviceable to my field-work. I came to the conviction that those two branches of investigation are contributing to the appreciation of the true nature of the eruptive rocks in a surprising manner; the mineralogical association also agreeing with the chronology of the eruptive rocks belonging to the same cyclus of eruption.

If you have no objection I will give a sketch of my classification of the Tertiary eruptive rocks:

1. *Basalt, Leucitite.*

2. *Augite—Anorthite, Trachyte* (no quartz, no biotite). This in its normal state is the porphyre trachytique of Beudant, the andesite of Buch, the augite of German geologists; in its modified state it can take up the habitus of greenstone (augite propylite), and in other circumstances it may become basaltic, but it is never rhyolitic.

3. *Biotite—Amphibole-Labradorite Trachyte.* Without or with quartz, without or with augite.

In its normal state it may belong to the "echter trachyt" of the Austrian geologist, or to the amphibole-andesite. It can take up the greenstone (amphibole-propylite), or the basaltic, and very imperfectly the rhyolitic modification.

In some Hungarian trachytes of this type the garnet occurs in the mineralogical association, apparently replacing the lime-feldspar. Of two labradorite-trachytes of the same country, the one being with, the other without garnet, the latter is younger.

4. *Biotite-Amphibole Andesin* (*oligoclase*) *Trachyte.* Without or with quartz, without or with augite.

In its normal state it may belong partly to the "echter trachyt," or to the amphibole-andesite; in its modified state it passes in some cases to greenstone (propylite), rarely to basalt (oligoclase basalt), but by taking up a pearlitic and sphærulitic structure, often to rhyolite.

5. *Biotite Orthoclase* (plagioclase) *Trachyte.* Without or with quartz; without or with amphibole.

In a normal state it may have the appearance of syenite or granite; in its modifications the rhyolitic in the highest degree (pearlite, pitchstone, obsidian) is often met with.

In Hungary volcanic activity also ended in an outburst of basalt, and it is convenient to give to it a special color on the map, though its formation may be regarded as an episode accompanying nearly every one of the four periods, so that not only the augite-anorthite trachyte has been followed by a basaltic outflow, but after the close of the biotite labr. trachyte eruption, an outburst of basalt took place also, in which some of the associated minerals of this trachytic type may be recognized; and so there may have been basaltic eruptions at the end of the biotite-andesite, and rarely of the orthoklase trachyte too; but such distinctions not being observable in the field, the custom of uniting them in the geological map is to be maintained.

The leucitite is closely allied with the orthoclase-trachyte; in Italy it is always to be found in the region of orthoclase-trachyte. It is a kind of basic modification of the biotite orth. olig. trachyte. It can be colored as basalt with some additional mark.

The greenstone modification has been produced originally by solfataric, and subsequently by metamorphic and still existing action. The rhyolite is the modification of an older acid-trachyte, in most cases of the biotite orth. olig. trachyte (with or without quartz), produced by submarine activity of a newer basic trachyte breaking up under it. The orthoclase being more easily fusible than the labradorite or the (nearly) infusible anorthite, and having the property of forming very fusible hydrosilicates much more easily than all the plagioclastic feldspars, is converted into the glassy hydrated compounds (rhyolites). Every rhyolite indicates the contact with a younger trachyte of a more basic character, in most cases with the augite-trachyte. The rhyolites may be of a different age, because every one of the three younger trachytic periods can have produced this modification; but the most characteristic pearlites and obsidians have, of course, been formed in the newest period of the trachytic eruption.

In such regions, where after the outflow of biotite orth. trachyte no new eruptions ensued, no rhyolite is to be found; the biotite orth. trachyte occurs in its normal porphyritic, syenitic or granitic state.

On the map the greenstone-trachyte (propylite) and the rhyolite, as important habitus-characters, are to be signalized by a secondary mark on the respective trachytes.

The chronological order has been established by means of the sedimentary formations formed wholly or partly by trachytic ejections, aided by the breaking of younger trachytic masses through older ones, in which case in the region of contact the minerals of two different types may be found mingled.

The trachytic types as enumerated according to their order of basicity, exhibit at the same time also the chronological series of the eruptions. The limits of time for the trachytic formation in Hungary are the following:

1. The eruption of the augite-anorthite trachyte took place in the Upper Miocene (Sarmatische Stufe).
2. The biotite-amphibole labradorite trachyte corresponds to the Middle Miocene (Mediterranean Stufe).
3. The biotite-andesite (oligoclase) trachyte appeared during the Lower Miocene.
4. The biotite orthoclase trachyte is the product of the beginning of the trachytic cyclus of eruption during the Upper Eocene.

For the field-geologist, who visits a country for the first time, such a detailed classification is of course impossible; he must be contented with a general one, but one which should still be in accordance with the former. He may arrive at that by means of some microscopical minerals, some habitus properties, aided in many cases even by panoramic characters of the single trachytic types, all that being taken into consideration not only on the eruptive rocks themselves, but also on the sediments containing trachytic fragments.

Two classes are easily distinguished: the augite-trachyte and the biotite-amphibole trachyte; the former is the younger, the latter the older. Since the time of Beudant, the "trachyte micassé amphibolique" has maintained itself and is well characterized by the microscopical minerals mentioned.

With the aid of rhyolites three classes can be established: the oldest trachyte being the biotite orthoclase (quartz) trachyte. The presence of pearlite and other glassy modifications involves two distinct types of trachytes; the rhyolite is the transformation of the older acid type by a younger one of a more basic feldspar, which remains in some cases concealed under the cover of the rhyolite, while in other instances it breaks through it. On the line of contact the highest degree of rhyolithism is perceptible, while with the increasing distance the normal state is more and more preserved.

The general features of these three classes are so prominent, that once acquainted with them, they are to be discovered every-where, notwithstanding the varieties, which are indeed numberless, but which do not exercise any influence on the fixed characters needed for the above classification.

The order of eruptions is the same not only in Hungary, but down southward as far as to the region of the active volcanoes of Italy and Greece. Vélain has found it so on the isle of Reunion; Professor Heddle Forster informs me, that in the Tertiary volcanos of the Hebrides the first out-flow is a granitic rock with orthoclase, the second an augitic rock with labradorite, the third amygdaloids and basalt with labradorite. The admirable work just issued, "Santorin et ses eruptions," by Fouqué, confirms this order also for that volcanic island; the amphibol-labradorite, more acid rocks are older, the augite labradorite-anorthite more basic rocks younger.

There is no doubt, that the trachytes of the Rocky Mountains will follow the same law; but as regards the limits of time, the cyclus of eruption may exhibit a difference in the relative age. It could have begun sooner in one country, and later in another, corresponding to distinct volcanic basins, formed in different times. As regards the cyclus of trachytic eruptions in Hungary, and in the western part of the United States, there are many indications that lead me to adopt the opinion that our cyclus antedates yours.

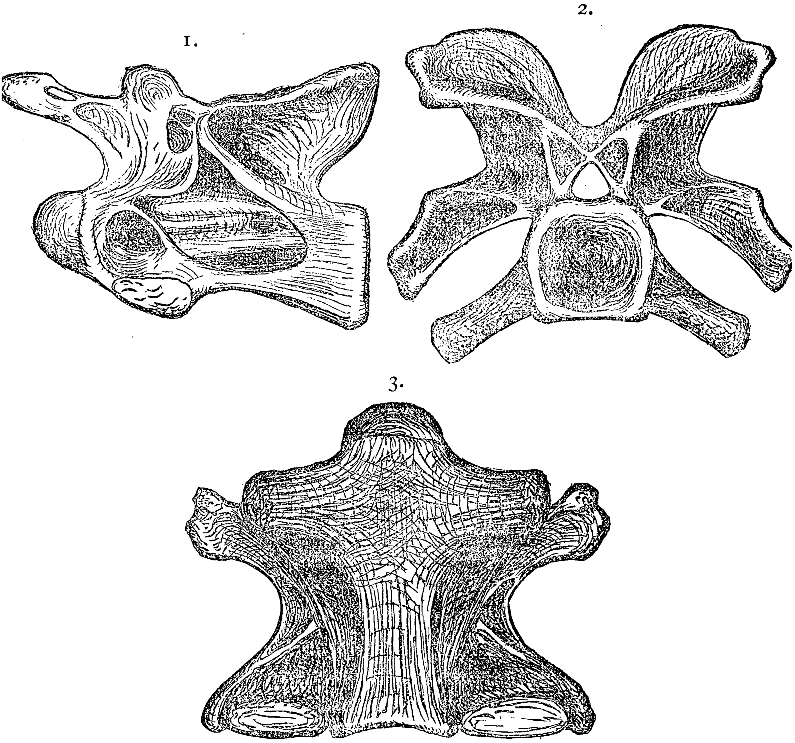
In order to enable us to pursue more extensive comparative studies, descriptions are not sufficient; the objects must be seen too, at least samples of rocks should be at our disposal. You are very generous and liberal, whenever the interests of science are in question; may I ask you to let me have some of your duplicates of typical rocks.

We have in Hungary a beautiful series of pliocene, miocene and eocene rocks, and so the age of eruptions can be well settled. Your series seems far from being so clear, and so complete, the connection between the trachytic series and the sedimentary formations is consequently not so evident.

I should like very much to have samples of your marine clays and sands of miocene and eocene also. Professor Hantken, the director of the Hungarian Geological Institut at Budapest, is the specialist for the nummulites, orbitoides and Foraminifera generally. It would be very good for science, if he could have an opportunity to make comparative investigations; while on the other hand, I could ascertain whether traces of volcanic sand are contained in them.—*Dr. Joseph Szabó, Prof. of Min. and Geology in the University of Budapest.* (*Extract from a letter to Prof. Hayden.*)

NEW JURASSIC DINOSAURIA.—A second species of *Camarasaurus*, from the Jurassic of Colorado, is indicated by three cervical vertebræ, and probably by other remains in my collection. The dimensions of these specimens are a little less than that of the largest neck vertebræ of the *Camarasaurus supremus*, but the average length is not very different. The proportions are characteristic. The centrum is little depressed, the vertical and transverse diameters of the cup being nearly equal. The form is thus much more slender than in the *C. supremus*, indicating a neck somewhat like that of the *Trionyches* or *Chelodinæ.*

The parapophyses descend backwards and downwards from the edge of the anterior ball; they are much shorter than the diapophyses, which are decurved. The side of the centrum and coössified base of the neural arch are excavated by a large fossa, which is somewhat subdivided. A smaller fossa is in front of it above the parapophysis. Still another divides the posterior base of the neurapophysis, on each side of the neural arch. The posterior zygapophyses support a strong superior crest, and their superior edges converge to meet at an angle without forming a neural spine at or posterior to the middle of the length of the neural arch, as is the case in *Epanterias amplexus.* The external bases of the zygapophyses are excavated deeply. Length of centrum m. .430; vertical diameter of cup, .140; transverse do., .160;



EXPLANATION OF CUTS.

Cervical vertebra of *Camarasaurus leptodirus,* one-tenth natural size. 1, right side; 2, posterior end; 3, inferior surface. Fig. 1 is taken from one vertebra; figs. 2 and 3 from another.

expanse of diapophysis, .380; of posterior zygapophyses, .450; elevation of do., .250; elevation of do. with crest, .360. The species is named *Camarasaurus leptodirus*.

Bones of an allied species recently received from Colorado, represent a most gigantic animal. The transverse diameter of the cervical vertebra is fifty-six inches, and that of the distal end of the femur, twenty-one inches.

A species of the carnivorous Dinosaurian genus *Hypsirhophus* has lately been received from another locality, which adds considerably to our knowledge of it. Vertebræ, limb bones and teeth found together, confirm the correctness of my supposition as to the true affinities of the genus.[1] The animal obtained is about the size of the *Hadrosaurus foulkei*. The dorsal vertebræ display the zygapophysial mass greatly elevated on a stem which has a quadrate section, with anterior and posterior grooves. There is no hyposphenal articulation. The diapophyses are wider than deep, are directed obliquely upwards from the superior margins of the zygapophyses, and have a prominent anterior superior border; the neural spine is short and compressed. The centrum is amphiplatyan and moderately compressed at the middle. The caudal vertebræ are not very elongate, and have a compressed hexagonal section. The chevron facets are on produced bases. Many of the teeth are less compressed than usual with Megalosauroid species, and have two denticulate edges. Length of dorsal centrum m. .100; vertical diameter of do., .084; transverse diameter of do., .073; elevation of postzygapophyses from centrum, .122; elevation of neural spine above centrum, .292; length of diapophyses below, .130; length of a caudal centrum, .048; depth in front .050; distal width of femur, .250. I name this species in honor of my friend Professor Seeley, *Hypsirhophus seeleyanus*.—*E. D. Cope.*

GEOGRAPHY AND TRAVELS.[2]

African Exploration.—To the account given in our last number of the various expeditions engaged in explorations on the western coast of Africa, we have now to add these further details. M. le Comte de Semellé who started from Fernando Po in May, 1878, to explore the upper Niger and Benué, returned to that settlement on February 13th, last, and has forwarded an account of his discoveries to Europe.

M. Soleillet has also been obliged to return to St. Louis, Senegal from Sego on the Niger, in consequence of the refusal of the Sultan of Sego to allow him to pass through his territory.

The *Athenæum* (April 12, 1878) gives the following astronomical observations taken by M. de Brazza, Okanda's residence amongst the Bateke, 1° 34′ 59″ S., 11° 59′ 48″ E.; Obemba, an

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[1] This journal, Feb. 23, 1878 (March number).

[2] Edited by Ellis H. Yarnall, Philadelphia.